partly on account of convection and partly perhaps on account of direct absorption.

A consequence of these conditions is that a number of the meteorological elements observed at the ice show periodic and unperiodic changes which are of a very local character because they take place within the cold layer directly above the ice. This circumstance seems to be of fundamental importance for the understanding of many of the meteorological conditions over the Polar Sea, and will be taken into account in the fuller discussion of the meteorological observations of the expedition.

METEOROLOGICAL CONDITIONS IN THE EURASIAN SECTOR OF THE ARCTIC

[A summary of the data and conclusions presented by Karl Schneider, A. Berson, L. Breitfuss, M. Robitzsch, R. Süring, A. Wegener, and K. Wegener, in "The airship as a means of exploration in the Arctic." [1]]

By BURTON M. VARNEY

[Weather Bureau, Washington, D. C., November, 1925]

It is perhaps not widely known in this country that an organization called the International Society for the Study of Arctic Exploration by Means of Airships is actively engaged in working toward a solution of this problem. It is composed of some 80 European scientists, including leading meteorologists, oceanographers, geographers, geologists, and polar explorers. Dr. Fridtjof Nansen is its president. There were, at the time the memoir here summarized was published (October, 1924), one American member and no English.

The problem of air navigation in the Arctic is essentially a meteorological one. Hence some 18 pages of the 60-page memoir are devoted to summarizing the pertinent available meteorological data, with special reference to the Asiatic sector. Cloudiness and fog, and wind directions, together with the controls over them, receive major attention.

Cloudiness and fog.—For the area north of 80° the only cloud data are from the traverse of the *Fram* in 1893–1896 from near the mouth of the Lena River to Tromsö in northern Scandinavia. The mean values are set out in Table 1. They indicate clearly a summer maximum of cloudiness, and the fact that the period of the long night had somewhat less than half of the summer amount of cloudiness.

Fog, while showing a summer maximum, was nevertheless nearly absent throughout the autumn, winter, and spring.

TABLE 1

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Cloudiness (1–10)												
3.7	4.4	5.6	5.7	7.2	8.5	8.8	8.8	8.2	6.4	4.4	3.7	6.2
Days with fog												
0	0	2	1	2	10	20	16	10	5	1	0	67

The intensity of development of clouds, fog, and precipitation * * * is, for the polar regions proper, very limited. According to the *Fram* observations the monthly amounts of precipitation were about 3 mm., although in one exceptional case in July there was a fall of 20 mm. in a day. * * * There is no month without snowfall. Rain falls mostly from May to September only, in any case in those areas which lie far from the open sea. The snow cover grows during the course of the winter to a very heavy mass through the condensation of atmospheric moisture on its surface, the temperature of which is mostly below that of the air. This form of precipitation it is not possible to measure. Rime and hoarfrost, on the other hand, while found on a few days, in general are observed only in limited quantity and in regions near the sea. Hoarfrost as we observe it in Europe, is to be classed among the rarities in the Arctic, because the water content of the atmosphere, on account of the low temperature, is so much smaller. The danger of an ice deposit on a traveling airship is therefore less likely than in Europe. An airship journey in the Arctic summer seems, therefore, as far as the meteorological factors are concerned, not seriously more difficult than a similar trip in the European winter.

For the border region of the Arctic in the Eurasian sector, cloudiness data are presented in Table 2 (Franz Josef Land and Spitzbergen), and in the large table at the end of this paper appear data for the five months March–July at 19 stations covering various periods (mostly less than 5 years) from 1 to 33 years. The distribution of these stations is shown in Figure 1.

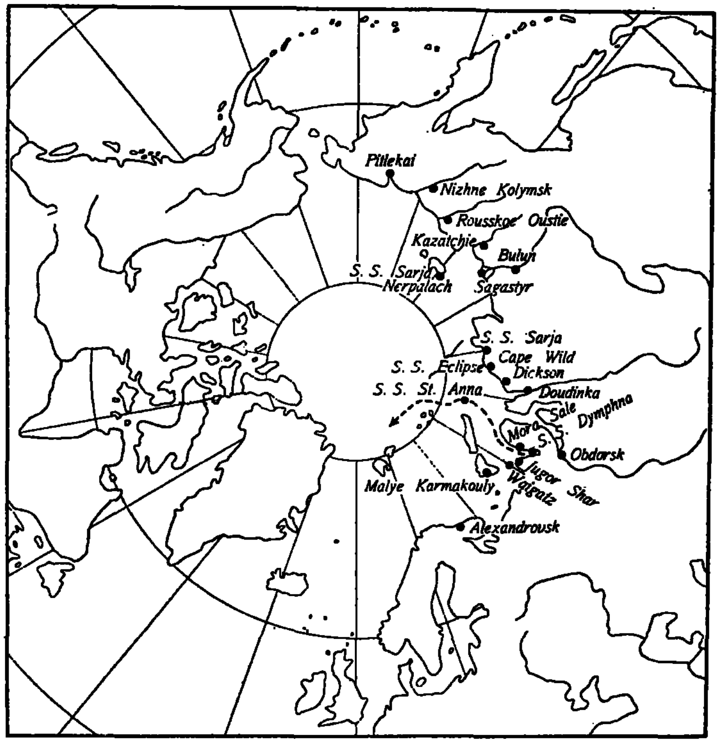

FIG. 1.—Stations represented by data in Table 8.

TABLE 2

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Franz Josef Land												
5.2	5.2	5.3	5.8	7.4	8.2	8.1	8.0	8.0	7.2	5.9	5.1	6.6
Spitzbergen												
6.4	6.3	6.1	6.6	7.3	7.8	8.0	7.9	7.8	7.8	6.9	6.1	7.3

So far as cloudiness is concerned, Franz Josef Land and Spitzbergen are dreariest in summer, with little to choose between them. In midwinter, however, while cloudiness at Franz Josef Land has declined to about 5, at Spitzbergen, nearer the open sea, it has decreased only to 6. These data are for cloudiness without respect to altitude of the clouds. At Dickson Harbor, in longitude

[1] Published by the Internationalen Studiengesellschaft zur Erforschung der Arktis mit dem Luftschiff, Oct. 7, 1924. (Copy received by the U. S. Weather Bureau Library from the Gesellschaft für Erdkunde, Berlin.)

about 80° E. at the mouth of the Yenesei River, pilot-balloon ascents were made in 1917 between January 12 and August 31. They throw light on the frequency of cloudiness above certain altitudes at that point in the sector, as follows:

TABLE 3

		Jan.-Apr.	May-August
		Per cent	Per cent
No ascents on account of bad weather		14	42
Measurements of balloon	below 0.5 km	11	16
	between 0.5 and 2	25	24
	over 2 km	50	18

The most striking facts shown by Table 3 are (1) that during the period January-April flights were either omitted or reached but a half kilometer of measurable altitude only one-quarter of the time, and that they made better than 2 kilometers of measurable altitude half the time; and (2) that the May-August period was quite the worst on the score of bad weather and low clouds, only 18 per cent of the flights being measurable beyond 2 kilometers.

For the general conditions in the region farther west, we have some evidence from Alexandrovsk (longitude about 34° E.) in the large table at the end of this paper, showing that the period March-April, 1909, was one of bad weather with much cloudiness and rain, though without winds of storm velocity and without fogs. This short period may or may not have been representative. It is at least suggestive.

Prevailing winds.—Since these will be the greatest factor in determining an air route from western Europe across the polar basin to the west coast of North America and the east coast of Asia, a knowledge not only of the general features of the pressure distribution and the resulting winds but also of the cyclonic and anticyclonic changes of wind and weather are of prime importance.

On the coasts of northern Asia the winds are strikingly regular. This rim of the polar basin may be briefly described as an area of dominating monsoon winds. This appears with great clearness at almost all the north coast stations, at which in the winter months the southerly winds prevail, indicating the outflow of air from the central Asiatic *hyperbar*, while as early as the spring months a profound change in the distribution of the winds takes place in such a manner that now northerly and northeasterly winds predominate. Clearly, the wind conditions of the Asiatic side give the impression of a marked monsoonal development.

Evidence of the existence of these monsoons at the surface in the Arctic fringe is given on the basis of four stations in the Eurasian sector and one in the North American sector.

TABLE 4.—*Wind frequencies in percentages*

	N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calms	Average wind force (m. s.) SW.-W.	NE.-E.
Franz-Josef's Land											
Winter	11	14	21	7	1	1	4	12	29		
Spring	6	8	20	12	3	3	7	9	32		
Summer	8	6	13	12	4	4	12	8	23		
Autumn	12	17	22	5	2	2	5	13	22		
Sagastyr (mouth of the Lena R.)											
Winter	1	3	8	19	23	19	13	6	8		
Spring	3	7	23	18	10	9	16	8	6		
Summer	7	13	30	17	5	6	11	10	1		
Autumn	6	6	10	12	14	18	21	12	1		
Ustjansk (East Siberia)											
Winter	1	1	6	18	22	26	16	2	8		
Summer	14	18	23	9	3	3	9	10	11		
Pitlekaj (Chukchi Peninsula)											
Winter	29	7	7	3	7	6	5	26	10		
Summer	20	12	9	4	14	19	5	12	5		
Point Barrow (Alaska)											
March	3	9	16	16	11	16	21	7	1	14	18
April	7	8	15	15	10	11	21	10	3	7	9
May	8	28	21	11	7	14	7	3	1	9	16
June	16	27	25	8	3	7	5	9	0	8	12

The vertical extent of the monsoons is important, but the only existing data on this point are not sufficient to form a basis for conclusions. They are the summary of pilot-balloon observations above Dickson Harbor, shown in Table 5. The monsoon is, of course, not evident, since the data cover both summer and winter months.

TABLE 5.—*Percentage distribution of high-altitude winds above Dickson Harbor (after P. Moltschanoff)*

Height (km.)	1	2	3	4	5
NE	17	16	19	13	19
SE	28	24	11	8	12
SW	31	27	31	38	27
NW	24	33	39	41	42
Number of cases	103	74	54	37	26

Cyclonic winds in the Arctic.—According to the *Fram* observations, the average *maximum* wind velocity in the polar basin proper was scarcely over 10 m./sec.; only very seldom were velocities over 15-18 m./sec. observed. In brief, the basin appears to be practically storm free.

Cyclones appear to be phenomena of the rim of the basin rather than of its interior, penetrating the basin but infrequently. What are the wind velocities in this border region?

For the sector which includes Spitzbergen, Franz Josef's Land, and Nova Zembla one may usually count on the region being overlaid with a low-pressure circulation. We have data (in the large table at the end of this paper) for Alexandrovsk and Maly Karmakuly showing for the earth's surface mean wind forces (Beaufort) ranging from 3.2 to 7.5, with calms at the latter station (on Nova Zembla, 33 years) ranging from 13 to 17 per cent of the time. With respect to the winds aloft, data are presented in Table 6 for maximum wind velocities up to 5,000 meters over Spitzbergen in the summer half (April-September) of the years 1912-1913. They show that the lowest maximum velocities occurred not at ground level but at some elevation less than 1,000 meters (12 m./s. at 500 m.)

TABLE 6.—*Maximum wind velocities over Spitzbergen, summer half, years 1912–13*

Altitude	0	500	1,000	1,500	2,000	3,000	4,000	5,000
Velocity (m./s.)	20	12	18	16	20	16	24	24

This point is of interest in connection with the question of the probable thickness of the polar cap of surface cold air, to be referred to later. In general, then, this sector of the rim does not appear to be excessively windy. This is in spite of the fact that, so far as they have been mapped, the traveling cyclones in this region have noticeably steep gradients. It is pointed out that allowance must be made for the great poleward increase in the deflective force of the earth's rotation and the consequent decrease of the gradient wind, as shown by Table 7.

TABLE 7.—*Gradient wind velocity in relation to pressure gradient and latitude.* (*Wind in m/s.*)

Pressure gradient	0.5	1.0	1.5	2.0	2.5	3.0
Latitude:						
10°	18.3	36.7	55.0			
20°	9.3	18.6	27.9	37.2	46.5	
30°	6.3	12.7	19.0	25.4	31.7	38.1
40°	5.0	9.9	14.9	19.8	24.8	29.7
50°	4.2	8.3	12.5	16.6	20.8	24.9
60°	3.6	7.3	10.9	14.6	18.2	21.9
70°	3.4	6.8	10.8	13.6	17.0	20.4
80°	3.3	6.5	9.8	13.0	16.6	19.5
90°	3.2	6.4	9.6	12.8	16.0	19.2

That is to say, in the Arctic strong pressure gradients produce only moderate winds. In the climatological observations of the German Spitzbergen Observatory [is found] an illustration of this in the fact that a pressure change is not always correlated with a great increase in wind velocity. In October, 1912, the monthly minimum pressure (737.7 mm.) was observed about 60 hours ahead of the monthly maximum (772.3 mm.). The surface wind in connection with this change amounted to 8 Beaufort (determined by the value 14–16 m/s), while the velocity at 4,000 meters altitude only rarely exceeded 20 m/s.

There is a distinct seasonal difference in the behavior of the cyclonic centers after they leave Europe on their eastward journey. In the colder season those remnants of cyclones which manage to get beyond Europe move mostly north of the Asiatic coast, from the region of Barent's Sea, proceeding thence slowly eastward to Bering's Strait, on account of the dominance of the Asiatic high pressure. They intensify the coastal southwest winds which are the winter monsoon flowing from this high pressure. The summer cyclones move mostly over the northern part of the continent (hence not over the polar basin proper) and serve to intensify the easterly and northerly winds which are the summer monsoon flowing from the relatively high pressure in the polar area toward the relatively low pressure over Asia.

At all seasons, from this polar storehouse of cold air, come the quasi-periodic southward thrusts of that air which, operating in conjunction with warm air streams from more southern latitudes, serve to energize existing cyclones or to produce new ones.

Weather charts for the polar region.—It is not practicable to reproduce here the five series of synoptic weather maps presented in the paper under consideration. These charts are based on the observations made during the international polar year 1882–83, and are of particular interest because it appears that of the many manuscript charts drawn on the basis of these observations only a very few have ever been published.[3] The five series are based on the North Atlantic charts referred to in the footnote, plus data from 21 high-latitude stations, including 6 polar stations all but one of which are north of 70°.

The polar cold cap.—Evidence is presented by the authors to show that in all probability the cap extends to no great height above sea level:

Disregarding the thermal influence, atmospheric pressure must decrease * * * from the Horse Latitudes toward the pole. The cold due to radiation, however, causes a collecting of cold air in the lowest atmospheric strata within the polar region proper. The equatorward boundaries of these cold air masses at the earth's surface Bjerknes has called the polar front. * * * This polar front does not extend symetrically about the pole. In the transition months the center of gravity of the cold air cap lies somewhere between the North Pole and the North American Archipelago, corresponding to the larger land masses there present. We have here on a large scale the same features as those shown on a small scale by the weather situations over every Arctic Archipelago, such, for example, as those shown for Spitzbergen by Kurt Wegener. According to that view the island produces a local high-pressure area which overrules the effects of the general pressure distribution, and clearly reveals itself by causing its own characteristic weather conditions. The wind blows from the interior through the fjords to the sea. The general movement of the air along the coasts is anticyclonic; and corresponding to this, the surface movement of the ocean also is anticyclonic, which consequently maintains the west coasts ice free, in contrast to the other coasts. Some aerological data will serve to make this clear, which we take from the discussion of G. Rempp and A. Wagner, "Temperature conditions over Spitzbergen" (publications of the German observatory in Spitzbergen). They present the temperature distribution on the occasion of several ascents.

On the ascent of the 8th of March, 1912, which took place within the zone of influence of a low pressure area, a cold stratum extended to some 200 meters above the earth's surface; during a transition weather type on the 15th of April it extended to only about 100 meters. Even on the ascent of March 23, 1923, when surface temperatures were much higher, the cold surface stratum extended to some 300 meters. * * *

A similar condition holds for the polar "anticyclone." Aerological records will probably confirm the fact of the slight vertical extent of the cold-air masses. As a corollary to this, it is likely also that the low-pressure areas of the far north extend to but a moderate height, and that their progression depends only upon the temperature conditions on their two flanks. In these regions the effectiveness of the general west-wind drift is inferior to that of the kinetic energy derived from the juxtaposition of air masses having different temperatures. That is, we must conclude that the velocity of progression of cyclones in the Arctic is less than in lower latitudes. Experience confirms this conclusion.

In harmony with this forward motion, the cold air in coastal cyclones over northern Asia must originate in the polar basin proper, while the warm air from the southwest, energized by the strong cyclonic activity in the region of Greenland, Franz Josef's Land, and northern Scandinavia, streams thence eastward along the coasts. The storehouse of cold for these low-pressure areas is * * * not the "Asiatic center of action."

Discussion.—It is of interest to compare the altitudes of the top of the cold stratum on various occasions, given in the above quotation, with the probable height at which occurs the minimum of wind velocity over Spitzbergen (Table 6). The figures point to the inference that this zone of minimum wind may correspond to that of transition from the polar cold cap (believed by the

[3] Charts for the 1st and 2d of February, 1883, after A. H. Hazen, are to be found in the Hann-Süring third edition of the Lehrbuch der Meteorologie; for March 8 and 9 as a supplement to the Observation of the Lady Franklin Bay Expedition, and for April 30 to May 3, 1883, in Edouard Vincent's On the march of barometric depressions of the Arctic polar region from the month of September 1882 to the month of August 1883. Academie Royale de Belgique, Classe des Sciences, Memoires, Deuxième Serie, III, Brussels, 1910. Vincent evidently drew daily charts for the whole of the international polar year, but published only those noted. The most complete published charting of the results of this year's observations are the "Synchronous weather charts of the North Atlantic and the adjacent continents for every day from August 1, 1882 to August 31, 1883, published under the authority of the Meteorological Council," London, 1886. These charts extend only to 70° north latitude, but are especially valuable on account of the ship observation from the North Atlantic.

authors to be very thin) to the overlying body of warmer air. Detailed knowledge of the conditions and changes in altitude of the zone are of considerable importance. If the assumption be correct that the polar cap averages but a very few hundreds of meters thick (and the aerological results cited leave little opportunity for doubt on that score), the question arises as to whether the southward displacement of such very thin slabs of cold air could function adequately in the energizing of cyclones in the manner described by the authors. There seems to be a difficulty in harmonizing this view with that recently expressed by Simpson to the effect that when displacements of polar air take place they appear to involve not only the whole thickness of the polar troposphere but part of the polar stratosphere as well.

If the reviewer's inference from the early part of the above quotation is correct, the idea expressed is that the Bjerknes polar front is the front *of the very thin layer of cold air* described. Now, the evidence in Table 6 points to the existence at the top of the cold layer, of a distinct boundary surface between this cold layer and the relatively warm layer above. That similar conditions exist north of northeast Asia also is shown by Doctor Sverdrup in the preceding paper in this issue of the MONTHLY WEATHER REVIEW. He points out that there is little possibility of an interchange of air between the lower cold layer and the upper "warm" one. It would appear, then, that the polar cold-surface stratum exercises a quite secondary function in the mechanism of polar cyclones and anticyclones. It may be regarded as a lubricant between the rough earth's surface (ice surface) and the air streams in these cyclones and anticyclones. Doubtless when an outbreak of polar air pushes the polar front into lower latitudes, the thin surface layer participates in the movement to some extent. But one finds it difficult to believe that its cold front is *the* cold front. The observed depth of polar air streams on the occasion of outbreaks of polar air in middle latitudes seems entirely against such a view.—*B. M. V.*

TABLE 8.—*Extract from observations on the north coast of Russia (L. L. Breitfuss)*

Stations	Month	Temperature			Wind										Days with—					Cloudiness	Precipitation (in mm.)
						Frequency (in per cent)															
		Mean	Max.	Min.	Velocity[1]	N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm	Storms	Fog	Precipitation	Clear weather	Cloudy weather		
Alexandrovsk, 1909[2]	March	−8.6	+1.8	−20.8	3.2	6	0	1	5	50	10	1	0	20	0	0	14	1	11	------	13.4
	April	−6.0	+2.5	−19.8	4.2	2	9	13	7	39	2	11	4	3	0	0	20	5	15	------	24.9
	May	+0.6	+8.8	−10.2	4.1	27	6	8	1	15	3	11	16	6	2	0	24	0	23	------	23.0
	June	+4.9	+23.4	−0.6	4.5	26	8	9	6	10	4	4	22	1	0	0	21	1	24	------	38.0
	July	+12.2	+26.9	+2.7	3.3	41	3	8	1	8	2	4	15	11	0	5	------	0	14	------	------
Malye Karmakouly 1876–1909.	March	−15.1	+0.9	−36.1	7.5	5	5	20	25	12	9	4	3	17	8	------	14	------	------	6.7	18.8
	April	−10.3	+5.7	−31.5	7.4	10	6	18	19	13	9	5	4	16	9	------	12	------	------	7.3	8.2
	May	−4.4	+13.2	−23.5	5.8	15	6	12	15	11	8	9	11	13	4	------	16	------	------	7.9	13.9
	June	+1.1	+16.1	−7.4	4.9	18	6	10	12	7	9	7	18	13	3	------	16	------	------	8.2	17.0
	July	+6.4	+22.1	−9.6	6.2	12	6	16	16	7	8	8	12	15	5	------	13	------	------	7.6	31.0
Waigatz 1914–1917	March	−20.0	−1.0	−37.0	Spring.	3	7	10	7	13	21	10	19	10	------	1	------	------	------	------	------
	April	−9.0	+3.0	−31.0											------	6	------	------	------	------	------
	May	−3.0	+4.0	−15.0												8	------	------	------	------	------
	June	+3.0	+10.0	−10.0	Summer.	7	26	13	5	5	12	10	10	12	------	18	------	------	------	------	------
	July	+7.0	+24.0	−3.0											------	16	------	------	------	------	------
Jugor Schar, 1914–1917	March	−21.0	0.0	−42.0	------	9	12	7	28	24	5	5	4	6	------	7	------	------	------	------	6
	April	−9.0	+3.0	−36.0	------	5	13	6	27	34	5	2	4	4	------	16	------	------	------	------	2
	May	−2.0	+6.0	−18.0	------	8	11	8	15	17	17	14	8	2	------	10	------	------	------	------	16
	June	+5.0	+22.0	−6.0	------	14	8	7	12	18	14	6	13	8	------	16	------	------	------	------	33
	July	+10.0	+26.0	−4.0	------	24	17	5	4	15	6	2	20	7	------	22	------	------	------	------	28
Mora Sale, 1914–1917	March	−22.0	0.0	−42.0	Spring.	2	4	7	14	8	28	21	12	4	------	0	------	------	------	------	------
	April	−10.0	+4.0	−33.0											------	4	------	------	------	------	------
	May	−2.0	+5.0	−17.0												7	------	------	------	------	------
	June	+5.0	+18.0	−2.0	Summer.	24	5	12	8	2	9	12	20	8	------	17	------	------	------	------	------
	July	+14.0	+26.0	−1.0											------	8	------	------	------	------	------
Obdorsk, 1891–1909	March	−16.7	+3.2	−47.4	4.4	9	14	5	7	14	13	9	5	24	4.7	0.3	7.0	4.6	10.2	6.1	6 5
	April	−9.9	+8.9	−33.2	4.8	8	19	5	4	13	12	12	7	20	4.4	0.7	5.7	4.3	11.6	6.3	6.7
	May	−1.0	+21.1	−25.7	5.2	10	21	7	5	9	11	16	9	12	3.9	0.8	7.8	2.8	16.6	7.4	18.6
	June	+7.7	+27.6	−5.6	6.3	12	21	7	5	7	9	15	14	10	6.3	0.5	7.5	1.6	14.5	7.5	35.4
	July	+14.2	+29.6	+0.7	5.0	12	22	9	5	10	11	10	10	11	3.3	0.9	9.8	2.3	14.1	7.1	49.3
Steamship Dymphna, 1883[3] (in southern Kara Sea).	March	−19.3	−4.5	−34.5	5.0	9	4	8	10	17	5	6	3	38	------	3	26	------	------	5.5	------
	April	−12.4	+1.7	−32.1	5.7	9	4	3	4	16	15	8	7	34	------	2	16	------	------	5.6	------
	May	−9.5	+3.0	−28.4	4.9	18	5	9	2	3	3	7	13	40	------	7	22	------	------	7.5	------
	June	−0.5	+3.2	−6.4	5.0	16	7	6	5	2	6	13	9	36	------	7	18	------	------	7.4	------
	July	+1.7	+4.9	−2.4	4.8	5	15	18	5	5	7	4	2	39	------	24	18	------	------	8.3	------
Steamship St. Anna, 1913 (between lat. 77°–79° N. and long. 71°–77° E.).	March	−22.6	−6.2	−39.0	------	21	4	22	15	5	4	7	17	5	------	------	------	------	------	------	------
	April	−8.6	+6.2	−25.0	------	13	13	17	10	13	13	11	8	2	------	------	------	------	------	------	------
	May	−3.0	+6.8	−13.7	------	14	11	8	12	7	19	13	16	0	------	------	------	------	------	------	------
	June	+3.0	+20.0	+1.2	------	9	3	8	13	4	22	22	18	1	------	------	------	------	------	------	------
	July	+3.4	+18.7	−1.2	------	8	5	7	8	2	33	21	15	1	------	------	------	------	------	------	------
Dickson, 1916–17	March	−27.2	−4.9	−41.0	------	14	11	7	10	3	33	18	1	3	23	1	14	4	13	6.7	2.2
	April	−20.0	+0.1	−36.4	------	20	15	33	1	0	13	9	3	6	9	8	10	7	15	6.4	6.9
	May	−4.6	+2.3	−13.1	------	2	3	19	14	13	22	14	8	5	13	9	12	0	30	9.8	9.2
	June	+0.8	+6.2	−2.4	------	3	14	29	8	2	9	16	11	8	0	22	13	0	29	9.7	18.8
	Muly	+6.2	+19.0	−1.7	------	11	22	24	4	5	13	11	4	6	5	20	16	0	27	9.2	30.1
Doudinka, 1912–1914	March	−28.8	−4.6	−46.0	6.2	9	1	24	13	13	11	1	12	16	4	3	8	11	6	5.1	4.3
	April	−13.0	+0.2	−36.1	7.5	11	19	20	4	6	10	9	10	11	8	1	15	6	11	6.5	13.6
	May	−4.1	+2.2	−14.4	7.7	17	28	6	6	10	15	9	9	0	8	2	16	1	19	7.3	12.1
	June	+4.4	+17.5	−6.8	6.8	14	17	9	16	8	8	12	12	4	4	3	15	0	22	8.6	45.3
	July	+10.8	+18.9	+1.9	7.2	22	37	6	3	3	8	6	12	3	6	1	19	0	22	8.7	72.3

[1] Wind velocities in m/s.
[2] Precipitation refers to the year 1908.
[3] Observations of wind velocity, days with cloud and days with precipitation are from the steamship Varna, which at this same time was drifting in the Kara Sea.

TABLE 8.—*Extract from observations on the north coast of Russia (L. L. Breitfuss)*—Continued

Stations	Month	Temperature			Wind										Days with—					Cloudiness	Precipitation (in mm.)
					Frequency (in per cent)																
		Mean	Max.	Min.	Velocity	N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm	Storms	Fog	Precipitation	Clear weather	Cloudy weather		
Steamship Eclipse, 1915 (Taimyr Coast near Cape Wild, 75° 40′ N., 91° 25′ E.).	March	−29.7	−4.8	−45.1	2.4	1	9	6	9	5	23	6	1	40	------	3	------	11	3	3.7	------
	April	−13.3	+1.8	−35.4	5.6	4	13	7	2	16	41	9	2	6	------	4	------	4	18	7.3	------
	May	−7.0	+4.7	−15.0	5.5	9	7	12	7	10	21	10	12	12	------	3	------	0	21	8.9	------
	June	+1.4	+10.2	−3.9	2.7	10	19	15	4	4	6	6	4	32	------	14	------	3	16	7.3	------
	July	+2.8	+15.1	−3.0	2.8	15	29	2	2	4	8	13	8	19	------	19	------	6	14	6.4	------
Steamship Sarja, 1901 (Taimyr coast, 76° 8′ N., 95° 8′ E.).	March	−22.8	−10.4	−40.9	4.8	2	3	16	13	9	26	7	1	23	------	------	------	------	------	6.6	------
	April	−23.1	−7.2	−39.1	5.2	3	5	9	3	2	13	18	17	30	------	------	------	------	------	4.4	------
	May	−8.8	+2.4	−29.6	7.0	1	6	16	10	17	17	16	3	14	------	------	------	------	------	7.6	------
	June	+0.4	+10.4	−8.2	7.1	7	10	7	10	20	18	22	4	2	------	------	------	------	------	7.9	------
	July	+2.8	+12.8	−1.7	6.4	5	4	13	11	7	19	27	9	5	------	------	------	------	------	8.4	------
Sagastyr, 1882–1884	March	−34.3	−18.6	−47.5	4.7	1	5	22	25	14	7	12	3	11	0	1	1	------	------	3.2	0.2
	April	−21.6	−4.3	−37.4	5.2	2	7	23	14	7	11	21	10	5	1	3	2	------	------	5.3	0.6
	May	−9.6	+3.3	−27.3	6.2	5	9	23	16	9	9	15	11	3	2	7	10	------	------	7.7	5.0
	June	+0.0	+12.5	−12.6	6.8	4	11	27	19	7	6	15	10	1	4	12	8	------	------	8.0	11.9
	July	+4.9	+12.1	−0.2	8.9	16	21	37	18	0	0	0	8	0	8	18	5	------	------	7.6	6.9
Bulun, 1914	March	−30.1	−12.4	−42.6	6.1	35	3	0	1	10	14	5	1	31	5	0	4	8	10	5.8	2.9
	April	−17.9	+3.0	−41.4	3.6	17	6	1	0	9	18	6	6	37	1	0	8	3	14	6.8	14.1
	May	−4.6	+7.5	−23.3	5.3	40	25	4	1	1	1	3	5	20	0	0	1	2	13	6.8	0.1
	June	+10.0	+26.4	−4.6	5.7	13	27	7	2	14	17	8	3	9	2	0	7	1	13	7.5	11.4
	July	+15.6	+26.9	+2.9	5.4	22	33	10	2	8	7	4	4	10	2	0	7	3	15	7.2	23.8
Kazatchie, 1901–1905	March	−26.5	−6.0	−46.8	2.7	1	0	8	21	13	12	15	6	24	0	0	8	13	3	3.7	3.1
	April	−17.9	−1.1	−39.2	3.5	7	11	14	5	5	8	17	14	19	1	2	8	7	9	5.0	4.2
	May	−5.0	+8.9	−28.5	3.9	9	9	20	15	6	4	13	15	9	0	4	8	5	12	6.3	8.3
	June	+7.1	+27.6	−6.8	4.8	9	7	25	11	4	3	10	18	3	2	6	12	4	14	6.9	26.8
	July	+10.4	+26.5	−0.8	5.2	13	12	18	9	5	5	11	23	4	3	4	15	3	15	7.4	29.0
Steamship Sarja, 1902 (Nerpalach Harbor, Siberia Island, 75° 22′ N., 137° 10′ E.).	March	−32.7	−24.6	−40.1	5.4	2	0	18	55	16	1	1	0	7	------	------	------	------	------	3.4	------
	April	−21.9	−11.8	−36.2	6.8	11	16	40	16	3	2	1	3	8	------	------	------	------	------	5.9	------
	May	−11.0	−0.9	−22.0	4.3	14	14	20	8	11	3	4	12	14	------	------	------	------	------	6.7	------
	June	+0.7	+4.4	−9.8	6.8	8	20	28	8	5	2	1	21	7	------	------	------	------	------	8.4	------
	July	+2.1	+7.8	−1.7	5.8	12	5	11	16	11	5	10	23	7	------	------	------	------	------	8.6	------
Rousskoe Oustie, 1895–1903.	March	−31.0	−14.1	−48.6	3.8	4	8	18	6	2	26	12	4	20	2	0	6	14	4	3.4	7.8
	April	−21.9	−3.0	−44.8	3.9	4	11	25	10	3	17	12	6	12	1	0	3	13	4	3.4	3.3
	May	−6.4	+6.2	−29.9	4.1	6	8	31	17	3	6	8	7	14	1	3	10	5	15	6.7	9.2
	June	+4.8	+29.6	−11.7	5.2	11	10	27	14	5	5	11	10	7	2	2	14	2	17	7.7	27.0
	July	+10.8	+28.5	−1.2	5.2	10	8	23	12	9	5	12	12	9	2	0	12	3	15	7.0	29.7
Nizhne Kolymsk, 1901–1905.	March	−27.1	−0.8	−48.6	2.4	6	6	12	29	6	11	7	5	18	1	0	8	10	4	4.0	4.7
	April	−15.4	+2.2	−38.0	3.2	9	9	12	27	6	6	8	8	15	1	0	8	10	7	4.6	6.1
	May	−2.0	+15.4	−31.3	3.2	16	9	10	21	7	9	8	8	12	1	1	6	6	7	5.4	6.3
	June	+10.1	+25.0	−0.8	3.4	15	9	10	25	9	7	8	12	5	1	1	6	5	6	5.3	17.5
	July	+12.1	+26.7	+0.4	3.1	20	8	10	19	7	9	9	12	6	0	1	12	4	10	6.1	34.3
Pitlekai, 1879	March	−21.6	−4.2	−39.8	------	29	6	2	6	13	8	7	24	5	------	------	------	------	------	5.1	------
	April	−18.9	−4.6	−38.0	------	37	6	2	2	5	8	6	28	6	------	------	------	------	------	6.4	------
	May	−6.8	+1.8	−26.8	------	24	19	13	3	8	5	8	19	1	------	------	------	------	------	8.5	------
	June	−0.6	+6.8	−14.3	------	29	7	2	2	14	20	3	16	7	------	------	------	------	------	7.0	------
	July	+2.7	+11.5	−1.0	------	10	16	16	7	15	18	7	8	3	------	------	------	------	------	7.5	------

THE EFFECTS OF A LIGHTNING STROKE

N. ERNEST DORSEY

[National Research Council]

On the night of Sunday, September 13, a tulip tree (*Liriodendron tulipifera*) in the yard of All Saint's Chapel, Annapolis Junction, Md., was struck by lightning. It was examined the next morning. On the following day it was inspected very carefully and photographs were taken. Other photographs were taken and inspections were made from time to time, for the purpose of confirming or of extending the memoranda previously made. The case is of considerable interest, as the effects produced give quite clear evidence of the direction of the stroke, and show that it was delivered to very restricted areas at points not over about 8 feet from the ground.

Some rain had fallen earlier in the evening; it is not known positively whether it rained much after the stroke, but the appearance, the next morning, of the ground in the corner by the steps (G, fig. 1), and the fact that leaves and dirt were still adhering to the wall of the tower (fig. 6) indicate that it probably rained but little after the stroke.

The prominent objects in the neighborhood of the tree are shown in Figures 1 and 2. Excepting a one-story concrete building about 60 feet to the east, there is no other tree or other prominent object to the west, north, or east within 200 yards of those shown in Figure 1. On the south there are trees, but the nearest is 75 feet distant. The group shown in Figure 1 is essentially isolated. The ground is nearly level to the south, west, and north, and slopes gradually downward toward the east.

The tree which was struck is A; it was 47 feet high, and 6 inches from the ground it had a girth of 49 inches. It stands between a 56-foot tower (wood, stone foundation, no lightning rod) and three other trees of approximately its own height; of these, two are of the same kind as itself. The highest and most exposed tree in the yard is B; it was not damaged in the least. The stroke ignored both B and the tower, passed in a vertical plane between C and D, each about 47 feet tall, and finally struck A about 8 feet from the ground. The most distant splinters were found at K and L; they were small. Small splinters were on the roof of the chapel, one was sticking in the frame of the door. The only large section torn from the tree lay at E; it was 14 feet long, and was bent about as indicated (see also fig. 7). At F, was a splinter 11 feet long, and 0.5 by 1.5 inches in section. With the exception of a 4-foot splinter which was caught in the branches, and which will be